

the pool, become "lost" and only regain the water by chance or, for a season, may even fail altogether to reach water and to propagate their kind. Field naturalists are well acquainted with the Newt's capacities for travelling.

6. That further experiments on a more extensive scale ought to settle this matter; suitable ponds, however, are difficult to find, particularly in this part of the country.

I hope those living in more favoured localities will be induced to carry these preliminaries to more decisive results.

In conclusion, I should like to thank Dr. R. M. Yerkes, of Harvard University, for the encouragement he has given me in this undertaking, and my sister for her services in obtaining specimens and in dredging.

2. Some Remarks on the Habits of British Frogs and Toads, with reference to Mr. Cummings's recent communication on Distant Orientation in Amphibia. By G. A. BOULENGER, F.R.S., F.Z.S.

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In the course of the discussion which followed Mr. Cummings's communication at the Meeting on October 24, I made some remarks on the habits of Batrachians, which the Secretary has asked me to embody in a short paper for the information of those who might feel inclined to carry on further observations in this country on the interesting subject with which Mr. Cummings has dealt.

There is great diversity among Tailless Batrachians in the possession, lack, or degree of instinctive foresight in selecting places for the deposition of their eggs. Leaving out the thoroughly aquatic Edible Frog (*Rana esculenta*), which has only doubtful claims to be regarded as British, two of our species, the Common Frog (*Rana temporaria*) and the Natterjack Toad (*Bufo calamita*), belong to the category of the least gifted in this respect, whilst the third, the Common Toad (*Bufo vulgaris*), behaves differently, and is besides possessed of an instinct for orientation which appears to be highly developed. The fact that, after the perfect condition is attained, Tailless Batrachians, unlike the Tailed, do not regenerate lost parts, would render the Common Toad further suitable for experiments on migrations, after the amputation of a finger or toe, as a distinctive mark. The Natterjack is, with us, a very local species, but the Common Toad and the Common Frog are ubiquitous and, as young or outside the breeding-season, are often found far from water, to which they have, of course, to resort for oviposition. How the three species behave in connection with this function I will tell briefly from my own observations.

The COMMON FROG exercises little discrimination in the choice

of water in which to deposit its eggs, provided it be not brackish, often spawning in temporary winter pools which are sure to dry up before the time at which the larvæ have completed their metamorphosis, or on the edge of a pond where, the level of the water falling after dry weather, the egg-clumps remain stranded. No doubt the frogs are attracted to the shallow, slanting borders in preference to the deeper parts with abrupt banks by the comparative warmth of the water under the sun-rays of late winter or early spring, with the unfortunate result which may be witnessed almost year after year in some places, when, following a spell of dry weather, the borders of ponds are covered with the stranded jelly-like masses of frog-spawn drying away in the sun before the liberation of the larvæ. On my country rambles in the end of March or beginning of April, I have often rescued the progeny of many frogs by removing such doomed egg-masses from these fatal beaches to deeper water close by, which the mother would have chosen had she been gifted with the instinct possessed by the Common Toad.

The migrations of the Common Frog towards the water must take place, to a great extent, in the autumn, as many, perhaps the majority of individuals, hibernate buried deep in the mud at the bottom of ponds, sluggish but not dormant as in some higher animals. Some years ago, just before Christmas, after a period of severe frost, which had lasted more than a week, I was walking on the ice of a small and shallow pond in Belgium, when my attention was drawn to a bright red creature, first taken for a gold-fish, moving under the ice, which very nearly extended to the bottom of the pond; this was a Common Frog, and on looking closer, I discovered hundreds of others, less conspicuous owing to their yellowish, brown, or olive colour. Some were very handsome specimens, which I wished to secure. A pick-axe was fetched from a neighbouring farm and a hole made in the ice, through which I could introduce my arm and reach the bottom; but the frogs were so active that they swam away and not one could be caught. I decided to return to the pond after the thaw, which I did, but no more frogs were to be seen; they had evidently retired to their hibernating-quarters in the mud and in holes under water. The reason why they came out when the pond was frozen nearly to the bottom, must be attributed to the reduced oxygen in the water, which made the frogs, breathing as they do under such conditions chiefly by the skin, feel uncomfortable and desire to escape.

The Common Frog is the earliest breeder among European Batrachians, spawning taking place in the South of England from between the end of January and the end of March, the date depending almost entirely on the temperature and therefore varying considerably from year to year. Should the winter be a mild one, the breeding may be over by the middle of February; recurrence of cold weather after the frogs have begun spawning may cause them to return to their winter-quarters, with the

result that the breeding-season is broken up into two or three periods within a couple of months. When the first appearance of mild weather is much retarded, the spawning takes place for all individuals within a very few days, with an *ensemble* which is not customary for the species in our uncertain climate.

The NATTERJACK TOAD does not undertake lengthy migrations for the purpose of depositing its eggs. It usually lives in colonies in sandy localities, such as dunes on the sea-coast, sand-quarries, heath-land, etc., which must be in close proximity to at least some sort of shallow pool, even of an intermittent kind. This toad shows not the slightest discrimination in the choice of water, and will not move any distance in search of better conditions if only it can find close by a little water in side ditches or even in cart-ruts of a road, whilst an excellent pond may be available a hundred yards off. The development of the eggs and larvæ, it is true, is much more rapid than that of earlier breeders like the Common Frog and the Common Toad, but nevertheless, in some places, a great many broods are destroyed through want of foresight on the part of the mother. Should, however, the pools or ponds in which the Natterjack is accustomed to breed, and around which it has settled, disappear for good, by the agency of man or otherwise, the whole colony will move off after a time to a more suitable locality. This I have observed in sand-quarries in Belgium and France, some of which are provided with stagnant water whilst others are not; those which have no water or from which the water has disappeared for a year or two, are without Natterjacks at all times of the year, thus showing that this gregarious Batrachian only settles down in such places as will afford a site for spawning within a few yards, whilst half a mile's journey is nothing to a Common Toad. It may also be mentioned that the Natterjack, in common with the Palmated Newt, has no objection to brackish water and is therefore often found in great abundance in close proximity to the sea. The greatest number I have ever seen was on the little ile de Bast, opposite Roscoff, on which, for the reason that the pools are brackish, neither frogs nor the common toad exist.

The Natterjack has no such restricted breeding-season as our other Tailless Batrachians. The females do not go to the water until ready to spawn, and the time at which the ova descend into the oviducts varies according to individuals, from between the middle of April to the beginning of July, sometimes even later.

The COMMON TOAD, on the other hand, is remarkable for the fixity in the time at which it seeks the water for the purpose of reproduction and for the shortness of the period within which all the females get rid of their eggs. Exceptions of later breeders, which have been observed, are so rare they may well be said to confirm the rule. The same may be said of isolated pairs occasionally found in places to which toads are not in the habit of resorting to breed.

The breeding-season in the South of England, the North of

France, and Belgium, falls within the last days of March and the first days of April, and, with the exception of severe frosty weather, which rarely occurs at that season, irrespective of the temperature. Then certain ponds or deep flooded quarries will be found alive with hundreds or thousands of toads which have congregated from the neighbourhood, often from a radius of half a mile or more. Thither all the toads have travelled with remarkable directness, passing other ponds or ditches of which they might avail themselves were it not for the instinct which leads them to select a place offering all guarantees for the successful rearing of their progeny. If a male meets a female *en route*, he vigorously clasps her under the axils and accomplishes the rest of the journey on her back. Much of the travelling takes place at night, but individuals are also met with in the daytime, hopping along towards the meeting-place. If a high road should run not far from the pond which is the rendezvous, numbers of crushed corpses of toads, run over by motor-cars or other vehicles, will be found for a distance of perhaps two or three hundred yards, the crushed toads being more and more numerous as the road nears the pond.

If pairing toads are taken from the place selected by them for spawning, and removed to a neighbouring garden with a small artificial pond in which, we should think, they might comfortably conclude their breeding-operations, they will often leave and start off in the direction whence they were brought. It does not matter to them whether this be up or down hill.

Some years ago I made an experiment on the instinct of orientation in this toad. I took a number of pairing individuals out of a pond frequented by the species, which was only a short distance from another in which frogs spawn but to which toads never resort. I turned them loose on a monticule midway between the two ponds, from which neither could be seen, and watched their movements. All, after a little hesitation or after a few hops in the opposite direction, took the right orientation and made their way straight towards the pond whence they had been taken. I experimented on single individuals, on pairs, and on groups of individuals, with the same result. In this case, it was evident that the toads were not influenced by hygroscopic sensations, since there was water in both directions. Whether the sounds uttered by their fellows in the pond were a guidance to them, seems to me doubtful, considering the very feeble voice of the Common Toad, the males of which, as is well known, are devoid of vocal sacs; if so, it would denote a very acute sense of hearing in toads. I am, however, convinced, from other observations, that even at a greater distance, from which no such sounds could be heard, the toads would have taken the right direction.

I strongly recommend the Common Toad as the most suitable Batrachian on which to institute series of experiments on distant orientation.